A POSSIBLE NEW PLANT HORMONE

A. K. Khudairi*

There are three major families of plant hormones, phytohormones: (1) auxins, (2) gibberellins, and (3) cytokinins. These are growth promoting hormones; the first two result in cell elongation and cell division, while differentiation is controlled by a combination of an auxin and a cytokinin. Other physiological effects of these hormones are known, e.g., auxin is connected with apical bud dominance, rooting, curvature of coleoptiles, partherocarpy of fruits, abscission of leaves and others. Gibberellin causes bolting of rosette plants, germination of seeds and production of reducing sugars. Cytokinins delay senescence and have an important role in cell differentiation.

From the definition of a hormone, three points have to be considered: (1) biosynthesis of the hormone within the organism, (2) translocation of the hormone from the source where it is produced to the site of action, (3) specific physiological effect of the hormone. Ascorbic acid was found to fit these requirements. First of all, ascorbic acid (AA) has been found in many plant tissues, i.e., buds, leaves, certain stages of floral development, and root tips of flowering plants (2,3,4). Ascorbic acid was found to occur in Chlorophyceae, Rhodophyceae, Pheophyceae, mosses, ferns, and conifers (1). It has been known as vitamin C to animals, hence it is essential to growth but animals cannot produce it.

Xanthium pensylvanicum leaves contain 100-500 mg. AA per 100 gr. fresh weight. The content depends on the physiological condition of the leaf as well as age. AA, when applied exogenously, moves from Xanthium

* Department of Biology, Northeastern University, Boston, Mass. 02115

leaves to the tested (receptor) bud. AA also was found to move downward when applied to decapitated Xanthium plants. The site of action is the undeveloped lateral bud. Such lateral buds developed more rapidly in the presence of AA than the water controls. Upward movement of AA was also observed with derooted plants immersed in AA solution. Translocation of AA within the plant satisfies the second point in the definition of a hormone.

The physiological effects of AA are: (1)enhancement of seed germination in lettuce seeds including percent germination and seedling growth (Fig.1), (2) removal of apical dominance executed by auxin over later bud development (AA application overcomes the inhibitory effect of auxin on the development of lateral buds), (3) enhanced development of flower buds, (4) increased growth of young leaves when applied to intact leaves or excised leaves floated in water or sugar solution. The increase in size of leaves treated with AA is small due to the presence of endogenous ascorbic acid in normal leaves.

Ascorbic acid is unlike gibberellin or cytokinin in its action; where gibberellin overcomes the dark inhibition of Grand Rapids lettuce seeds germination, AA cannot. AA increases the germination rate in the presence of red light, whereas AA is inactive in lettuce seed germination (Table 1). The hormonal action of AA is red - far-red reversible. It appears that AA action is phytochrome mediated. This effect of hormonal activity is not limited to lettuce seeds, but also found in Xanthium bud development (Table 1). Lateral bud development was more pronounced when the plants were given 5 minutes of red irradiation in the presence of exogenous AA applied to the leaves. Five minutes of far-red inhibits AA

action and the lateral buds develop like the control, without AA. The biosynthesis of AA was observed with other plants. Schopper, 1966, 1967 (5 & 6), found more endogenous AA synthesized in mustard seedlings (Sinapis alba L.) in the presence of red light. Far-red irradiation resulted in less biosynthesis of AA.

This new hormonal action of AA may lead to the suggestion of a fourth family of growth hormones, "the Photophytohormones."

Table - 1

Photoresponse of ascorbic acid to red and far-red irradiation in the development of lateral bud of Xanthium and Grand Rapids lettuce seeds germination. Single-leafed Xanthium plants were treated for 3 days and 100 mg/L AA solution was applied to the upper surface of the leaf. Grand Rapids lettuce seeds were germinated in the presence of AA (100 mg/L) or distilled water. Germination percent was measured three days after the beginning of water or AA solution inbibition.

Light Treatment	Bud Development of Xanthium (mm length)*		Grand Rapids lettuce seeds (% Germination)**	
	+ AA	- AA	+ AA	- AA
Red (5 min.) then in Darkness	4.95	3.7	38	23
Far-Red (5 min.) then in Darkness	3.6	3.4	0	2

* Mean of eight plants.
** Mean of two lots of 100 seeds each.

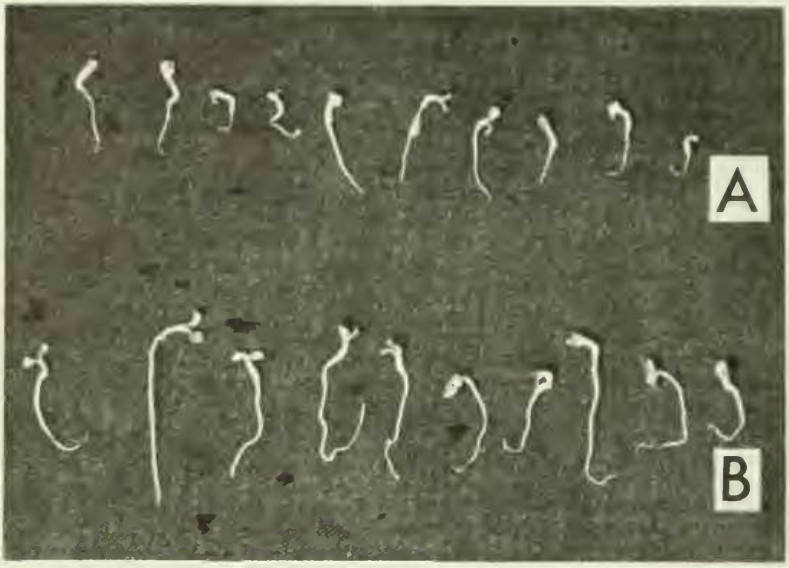

Figure 1- A. Seedlings of lettuce, Lactuca sativa var. Grand Rapids germinated in distilled water at 23° C in lighted growth chamber. B. Lettuce seedlings of the same variety germinated under the same conditions with the exception of the presence of 100 mg/L AA solution as the germinating medium. Photograph taken when seedlings were 6 days old.

References

1. Aberg, B. (1958) Encyclopedia of Plant Physiology, Vol. VI. Edited by W. Ruhland. Springer-Verlag. Berlin. Gottenberg. Heidleberg. pp. 479-499.

2. Reid, M.E. (1937) Amer. J. Bot. 24: 445-447.

3. _____. (1938) ibid. 25: 701-711.

4. _____. (1941) ibid. 28: 410-415.

5. Schopfer, P. (1966) Planta 69: 158-177.

6. _____. (1967) Planta 74: 210-227.